LETTERS TO THE EDITOR

Growth of Needle-Like Hematite Crystals during Re-Oxidation of Porous Metallised Iron Pellets at Relatively High Temperatures

The growth of hematite crystals of a particular shape, such as whisker, blade or platelet, on dense iron specimens has been observed⁽¹⁾⁽²⁾ during oxidation at relatively low temperatures under limited conditions. At higher temperatures this kind of hematite growth seems to be hardly observable, except a very special case, though the outer surface of hematite is usually undulated⁽³⁾ as shown in Photo. 1(a).

However, an outstanding growth of needle-like hematite crystals was observed during re-oxidation of porous metallised iron pellets at temperatures between 973 and 1173 K in the present study as shown in Photo. 1(b).

The metallised pellets were prepared by the hydrogen reduction of an acid pellet at temperatures between 973 and 1173 K resulting in corresponding porosities of the pellets 0.59 to 0.64. The compositions and other properties of the pellet, the reducing conditions and its

procedures have been reported previously⁽⁴⁾. The re-oxidation was carried out in N_2 - O_2 gas mixtures under atmospheric pressure with oxygen partial pressures between 4.8 and 15 kPa.

The growth characteristics of the hematite crystals varied slightly within the present experimental conditions. Similar hematite growth was also observed with a few other self-fluxing pellets and pure hematite pellets made of chemical reagent powder though to lesser extent for the latter.

A series of metallographic examinations of specimens after specified periods of re-oxidation revealed that the growth of the needle-like hematite crystals began after a continuous oxide scale had covered the specimen surface almost completely as shown in Photo. 2.

It has been shown⁽⁵⁾, on the other hand, that the oxidation of dense iron at the present temperature range is associated with the generation

Photo. 1 Features of outer surfaces of oxide scales formed (a) on dense iron strip after the oxidation at 1173 K for 1800 s in a purified oxygen flow and (b) on porous metallised iron after oxidation at 1173 K for 3600 s in a gas mixture of oxygen and nitrogen flowing at 3.3 cm³/s and 33.3 cm³/s, respectively.

Photo. 2 A cross section of the specimen after re-oxidation at 1173 K for 3600 s showing the outermost hematite layer associated with needle-like crystals.

of compressive stresses of considerable amount. Then, it may be said that the rate of stress generation during the present re-oxidation of the porous iron is much higher than that for dense iron because of the larger specific surface area.

Therefore, the growth of the needle-like hematite crystals can be attributed to the higher rate of stress generation, since the outward growth of the crystals may have acted as a stress relief process.

The volume increase resulted from the

oxidation within a limited space of micropores may also have contributed to the stress generation.

Impurities originated from gangue minerals containing CaO , Al_2O_3 , SiO_2 and so on may have some influence upon such crystal growth, since a different extent of such crystal growth was obtained for the metallised iron from pure hematite.

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